Concept Maps in Nursing Education: A Historical Literature Review and Research Directions

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ABSTRACT

Background: Although concept mapping was created in the early 1980s, research in nursing education first appeared in 1992. This literature review analyzes the impact of concept mapping in nursing education. **Method:** A total of 221 articles, books, and book chapters were reviewed on the topic of concept mapping in nursing education. **Results:** Results indicate that concept-mapping research progressed from the emergence state, to an expansion and adaptation stage, to an established stage. **Conclusion:** Nursing education could benefit from further research on applying concept map scoring formulas, using concept maps with simulation, developing knowledge models, and creating concept map–centered learning environments. [*J Nurs Educ.* 2016;55(11):631-639.]

Over the past 25 years, the science of nursing education has advanced dramatically, in no small part due to the commitment of nurse educators to find and implement evidence-based practices in undergraduate and graduate nursing education. In addition, the National League for Nursing (NLN) implemented its Centers of Excellence program (http://www.nln.org/recognition-programs/centers-of-excellence-in-nursing-education), including centers focusing on the science of nursing education, thus supporting nursing education research. Within the nursing profession, both the advancement of the science of nursing and the advancement of the science of nursing education have strengthened nursing science, clinical practice, and teaching–learning within nursing curricula.

CONCEPT MAPS

One way to continue to strengthen the science of nursing education is to trace the development of educational innovations with an eye toward future research. Concept maps, an educational innovation from science education, have been used in nursing education for more than 25 years. A rich history of research supports their development and use. The purpose of this article is to trace the development and implementation of concept mapping in nursing education, summarizing the evidence of their use and setting directions for future research in this area.

Concept maps were created by Novak and Gowin (1984) and are "a schematic device for representing a set of concept meanings embedded in a framework of propositions" (p. 15). Concept maps are based on the assimilation theory of meaningful learning created by David Ausubel in 1963. The assimilation theory of Ausubel (1963, 2000) and Ausubel, Novak, and Hanesian (1986) has components of both cognitive and constructivist learning (Merriam, Caffarella, & Baumgartner, 2006). In Ausubel's view, learners think and learn with concepts, making concepts meaningful by the ways in which connections between concepts are developed in the learner's cognitive structures. Using concepts to learn in a meaningful manner happens in three ways: subsumption, progressive differentiation, and integrative reconciliation. In the subsumption process, lower

order concepts are nested under higher order concepts. Within progressive differentiation, concepts are divided into finer and finer distinctions, similar to an analysis process. Finally, by using integrative reconciliation, concepts are linked together in a synthesis-type process to form an integrated whole.

Based on their research, Novak and Gowin (1984) created concept maps as a method to operationalize Ausubel's learning theory. To create a concept map, the learner uses the three processes outline above. First, the learner identifies concepts that are part of the topic in question. Second, the learner places more general concepts at the top of the map and more specific concepts below the general concepts. The learner then ties the general and specific concepts together with linking words that portray a specific meaning. Finally, the learner looks for interconnections from one side of the map to the other. The learner uses linking words to create these horizontal connections as a way to synthesize the developing knowledge.

One aspect of creating concept maps that is often difficult for learners is the selection of linking words. The linking words between concepts are most often verbs and are important because the linking words that are selected change the meaning of the relationship between the two concepts. For example, in creating a map on the concept of *blood pressure*, a linking word may be *includes*, to explain systolic and diastolic. However, if we change the linking words and indicate that *blood pressure does not include* systolic and diastolic, then an entirely different meaning is portrayed.

LITERATURE REVIEW

Literature reviews can be conducted in a variety of ways. Grant and Booth (2009) identified a typology of 14 review types each with different methodologies. What is evident from their analysis is that it is important to be clear on the purpose and methods used in a literature review. This allows the reader to evaluate the scope, rigor, and quality of the review conducted.

The purpose of this literature review is to provide a historical analysis of the development of concept maps in the field of nursing education. Adams (1987) helped explain why historical reviews are important. He stated:

> A sense of history helps an investigator lock onto important themes. Experiments enriched by history could contribute to the science rather than only brightening an inconsequential corner. Second, a sense of history tends to shunt an investigator away from the fads and fashions of his or her field. Fads and fashions are those inconsequential corners that are temporarily magnified out of proportion and that draw the energy of investigators who either have not seen the worth of persisting themes or who allow themselves to be turned from them. Third, the canons of scholarship are based on history because they require that (a) the origins of ideas be known so that one's own ideas are in perspective and, (b) earlier experiments be known so that the knowledge increment in one's own empirical findings is clear. (p. 41)

Keeping Adams' (1987) comments in mind, the current literature review analyzes the progression of research that fostered the development of concept maps in nursing education. The themes of these works are extrapolated, the origins of the

ideas are explained, and the progression of the knowledge created is described. This literature review is significant because as the history of the work to date is reviewed and summarized, it allows for the establishment and articulation of future research directions.

The literature in this review was obtained by searching library databases including Academic Search™, ERIC™, EBSCO*host*, PsycINFO®, PsycARTICLES®, PubMed®/MEDLINE®, CINAHL®, and EMBASE™. The initial search yielded 535 manuscripts. The literature review reported in this article is a summary of both conceptual and empirically published literature on the uses of concept mapping in nursing education from 1990 to 2015. All articles found describing interventions, conceptualizations, and assessments of concept maps in nursing education during this period were included. In addition, to provide context and situate the work in nursing education to that in other fields, selected papers from the Concept Mapping Conference conducted from 2004 to 2014 were included, along with studies in medicine and other clinical practice disciplines in the health professions. Finally, studies using concept maps in patient education were included. After the articles were identified and obtained, a matrix was created that identified the author, year, purpose, sample, methods, findings, and conclusions of each article. The final review included a total of 221 articles.

Certain manuscripts were excluded from this review because they did not use Novak's and Gowin's (1984) definition of concept mapping and meaningful learning. In addition, manuscripts that had no connection to nursing education were excluded. These exclusions included studies in biology education, nursing nomenclature studies that mapped computer knowledge bases, and research articles that were based on a different definition of concept mapping as defined by Trochim and Linton (1986). In addition, concept analysis articles that used the conceptual framework of Walker and Avant (1988) were excluded because those articles did not use concept mapping in the methodology.

FINDINGS

Kinchin (2015) reviewed the development of concept maps at the International Concept Mapping Conferences and indicated that the development of concept maps went through stages, with the first of these being emergence, where concept maps were introduced and tried in various areas. The second stage, consolidation, meant that the research demonstrated that across a wide variety of learners, different programs, and various pedagogical applications, concept maps were effective in facilitating learning. The third stage, transformation, is currently occurring and challenging the status quo of education delivery in various fields. Findings from the current literature review indicate that the development of concept maps in nursing education has gone through these three stages.

The **Figure** is an adaptation of the time line proposed by Kinchin (2015) and depicts the development of concept maps in nursing education. Concept-mapping research in nursing education progressed through similar stages as defined by Kinchin (2015), but with some distinct differences. Within nursing education, these stages began with emergence, when concept maps were introduced and examined in a variety of areas. Second, an
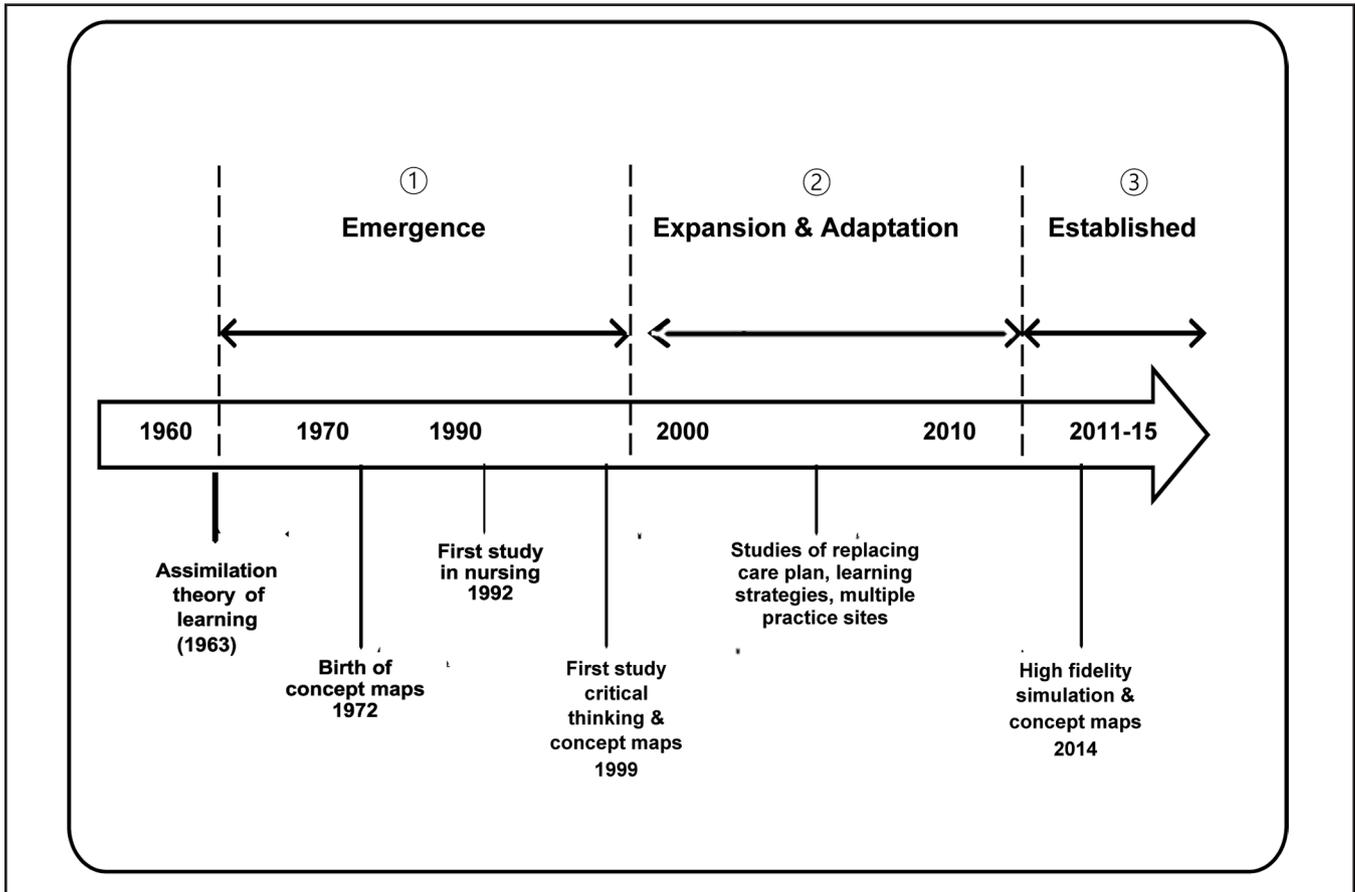
Figure. Historical development of concept mapping in nursing. Adapted from "Novakian Concept Mapping in University and Professional Education," by I. Kinchin, 2015, *Knowledge Management & E-Learning*, 7(1), 1-5. Copyright 2015 by Ian Kinchin. Adapted with permission. Also adapted from "Making Interdisciplinarity Visible Using Concept Mapping," by G.B. Cordeiro, P.L. Aguiar, C.A.T. Cicuto, & P.R.M. Correia, 2012, Paper presented at the Concept Maps: Theory, Methodology, Technology Proceedings of the Fifth International Conference on Concept Mapping, Valletta, Malta. Copyright 2012 by Paulo Correia. Adapted with permission.

expansion stage occurred, when the purposes of mapping and a variety of approaches were applied to different populations and sites within nursing education. Within the expansion stage, an adaptation stage also occurred, when the original intent of the maps was modified and altered. This modification seems to have occurred without a solid grounding in the theoretical underpinnings of the concept maps. Various graphic organizer strategies were discussed and labeled as concept maps, but they did not contain the necessary conceptual elements needed. Finally, the research on concept mapping has moved into an established stage, but there remains a need for a continued transformative stage.

Emergence (1992-1999)

Even though concept mapping has been around since the early 1980s, the first article on concept mapping in nursing education appeared in 1992. Smith (1992) reported on a study in which concept maps were used to support students in linking theoretical concepts from anatomy and physiology to the conduct of nursing skills within the setting of a skills laboratory. That same year, Wood (1992) discussed the use of concept map-

ping in teaching information about AIDS to nursing students. During this same period, Patterson (1994) used concept mapping as part of the methodology and data analysis process in a study that sought to understand nurse educators' perspectives on clinical teaching. Irvine (1995) conducted the first literature review on concept mapping in nursing education and addressed why and how concept maps could be used in nursing education. In 1996, Daley reported on a qualitative study that sought to understand how nursing students link theoretical material to clinical practice. In that study, concept maps were used as a data reduction method for student interviews. Findings from the study indicate that nursing students did not link the elements of the nursing process together, clinical preparation was not linked to theoretical material, and the meaning students made of the information was different than meaning interpreted by the instructors (Daley, 1996).

Additional studies and articles in this time period demonstrated that concept maps helped students synthesize pharmacology content (Gains, 1996), interrelate information about patient illnesses (Gendron, 1996), invest in a teaching and learning strategy in nursing education (All & Havens, 1997;

Beitz, 1998; Wilkes, Cooper, Lewin, & Batts, 1999), use active learning in large classrooms (Cravener, 1997), and foster clinical learning (Baugh & Mellott, 1998; Boblin-Cummings, 1999; Kathol, Geiger, & Hartig, 1998; Paterson, 1997). Research also began to explore concept maps as a methodology to teach critical thinking in nursing (Daley, Shaw, Balistrieri, Glasenapp, & Piacentine, 1999).

It is interesting to note that during this period, nursing education researchers were looking at concept maps as a teaching and learning tool, specifically to assist students in linking theoretical material to clinical practice and also to understand the teaching and learning process in which students and faculty engaged. Researchers in other disciplines chose a different route. For example, researchers in medical education and veterinary education looked at concept maps more as a curriculum development tool and as a tool to assist in designing problem-based learning cases (Edmondson, 1994; Patrick, Worth, & Hardin, 1996; Wang, Contino, Ramirez, & Levy, 1997).

Expansion and Adaptation (2000-2010)

During the 10-year span from 2000-2010, the research and scholarly writing on the use of concept maps in nursing education expanded. Researchers at that time were mainly assessing the use of concept maps in four areas.

First, concept maps as an alternative approach to traditional nursing care plans were assessed. Black, Green, Chapin, and Owens (2000) advocated for the use of concept maps instead of traditional care plans after they used concept maps with associate degree nursing students in clinical experiences. Schuster (2000) used concept maps instead of care plans in a medical–surgical clinical course within an acute care facility. In that work, the author described less paperwork, students' enhanced critical thinking, and that concept maps assisted students in identifying relationships in patient data. Castellino (2002) evaluated the use of concept maps rather than care plans with RN students in Pakistan. In that article, students and faculty reported that the maps provided a holistic view of patients and helped the students learn to integrate information. In 2004, Ignatavicius wrote a book chapter that outlined moving from traditional care plans to concept maps. She called these maps *clinical correlation maps*, meaning they were concept maps in a clinical setting. In a quasi-experimental pretest–posttest design study with junior-level baccalaureate nursing students, Hinck et al. (2006) found that concept maps significantly improved students' ability to see patterns and relationships, along with improvements in planning and evaluating nursing care. Overall, these studies and scholarly writings indicated that concept maps were a viable alternative to traditional care plans.

Second, nursing education scholars were evaluating and assessing the ways in which concept maps functioned as a learning strategy (Abel & Freeze, 2006; August-Brady, 2005; Banning, 2006; Bowles, 2006; Brunt, 2005; Chabeli, 2010; Clayton, 2006; Ellermann, Kataoka-Yahior, & Wong, 2006; Fonteyn, 2007; Garrett, 2005; Gul & Bowman, 2006; Harpaz, Balik, & Ehrenfeld, 2004; Hay, 2007; Hicks-Moore, 2005; Hicks-Moore & Pastirik, 2006; Hill, 2006; Hsu, 2004; Hsu & Hsieh, 2005; Johns, 2003; Kinchin & Hay, 2005; King & Shell, 2002; Laight, 2006; Latini, 2009; Luckowski, 2003; Pardue,

Tagliaren, Valiga, Davison-Price, & Orehowsky, 2005; Pilcher, 2009; Senita, 2008; Staib, 2003; Vacek, 2009; Veo, 2010; Walsh & Seldomridge, 2006; Wheeler & Collins, 2003). This body of work looked at concept maps as a strategy to promote meaningful learning, a method for collaborative learning, a strategy to promote higher level thinking, critical thinking and clinical decision making, and a methodology for fostering the linkages between theory and practice in a clinical setting. One article in this group (Zori & Morrison, 2009) even discussed how concept maps supported the development of critical thinking in nurse managers. Overwhelmingly, the evidence indicated that concept maps could play a powerful and effective role in all of these areas. This work demonstrates that the maps are a flexible tool that can be used in multiple ways to foster the development of thinking and learning in nursing education, as well as in clinical practice.

Third, nurse scholars were considering the ways in which the use of concept mapping could be applied in a variety of educational areas and practice settings. The use of concept maps was studied in critical care (Dobbin, 2001; Hart, 2000), staff development (Phelps et al., 2009; Zimmerman & Pilcher, 2008;), RN education (Speziale, & Jacobson, 2004), continuing education programs for nurse prescribers (Banning, 2006), the operating department (Sewchuk, 2005), graduate student learning (Giddens, 2006), online courses (Conceição & Taylor, 2007; Ertmer & Nour, 2007), new graduate transition programs (Bratt, 2009; St. Cyr & All, 2009; Wilgis & McConnell, 2008), and neonatal intensive care (Zimmerman & Pilcher, 2008).

Fourth, concept maps continued to be used as part of qualitative methods in nursing education research studies. They were used both as a way to conceptualize research and as a strategy to analyze qualitative research data (DeAngelis, 2007; Hicks-Moore, 2005; Larue, 2008). In addition, research on clinical teaching and teacher development that had been initiated when concept maps were introduced continued during this time (Kinchin, Cabot, & Hay, 2008).

During this time, two additional studies provided important steps for future work. However, they have received less attention in the literature. Kostovich, Poradzisz, Wood, and O'Brien (2007) conducted a quantitative study of 120 undergraduate nursing students to examine the relationship between learning styles and the students' aptitude for concept maps. Findings of that study indicate that learning style preference does not play a role in students' ability to perform well when using concept maps. The study is important because there has been a great deal of critique of the use of learning styles in education (i.e., students learn better when taught in a way that matches their style of learning). Kostovich et al. (2007) showed that concept maps are an effective learning tool in nursing education, regardless of the students' preferred style of learning.

A second interesting and less well-known manuscript was that of All and Huycke (2007), who reported on the use of serial concept maps to foster graduate nursing student thinking. By serial concept maps, they meant a series of maps about a specific concept that are developed over time. They stated that serial concept maps allow for a sophisticated exploration of theories, concepts, and other key issues within graduate nursing education. Serial maps also have the potential to demonstrate how

student and practitioner thinking has changed over a specified period. This may have future applications in graduate education, RN education, and also the orientation of new graduates to clinical practice.

During this time, the use of concept maps also expanded in both patient education and medical education. Concept maps were used in patient education to assess obese diabetic patients' knowledge of nutrition (Franca, Marchand, Basdevant, & d'Ivernois, 2003), to collect data on women's knowledge of osteoporosis (Terrio & Auld, 2002), to understand patients' knowledge prior to bariatric surgery (Marchand et al., 2007), and to understand patients' adherence to cardiac rehabilitation programs (Graham, 2003). In medical education, studies compared student and instructor concept maps (McGaghie, Mc-Crimmon, Mitchell, Thompson, & Ravitch, 2000), assessed learning in resident physicians (West, Pomeroy, Park, Gerstenberger, & Sandoval, 2000), investigated case-based learning and problem-based learning outcomes using concept maps (Eitel, Kanz, Hortig, & Tesche, 2000), measured students' attitude toward preprepared concept maps in light of their learning style (Laight, 2004), investigated the learning processes of third-year medical students (Torre et al., 2007) and explored concept maps as a method to identify clinical reasoning in medical students and experts (Pottier et al., 2010). Finally, medical education researchers explored both structural and relational scoring formulas for concept maps (West, Park, Pomeroy, & Sandoval, 2002).

Adaptation (2000-2010)

As often happens with innovations, the fidelity of the innovation tends to get modified in its implementation. Sometimes the modifications are improvements on the innovation, and at other times the modifications decrease the strength of the innovation. This modification or adaptation process of concept maps in nursing education happened during the 2000-2010 period. These adaptations tended to conflate mind maps and concept maps, bypassing linking words between concepts and also by avoiding the use of cross-links or integrative reconciliation of concepts across bodies of knowledge.

Several authors (Harpaz et al., 2004; Luckowski, 2003; Schuster, 2000) reported on the positive learning outcomes of their work with concept maps, and yet the examples shared in published manuscripts did not use linking words between concepts, nor were there horizontal connections (i.e., integrative reconciliation) between concepts. It appeared that this adaptation came from a misunderstanding of Novak's and Gowin's (1984) original work on concept maps and the theoretical framework of assimilation theory of learning (Ausubel, 2000) that supports proper concept map development.

Eppler (2006) published an article that compared concept maps to mind maps, conceptual diagrams, and visual metaphors. Eppler (2006) clearly defined the different types of graphic organizers and also indicated that different learners may need different tools depending on what they are learning. Despite this definitional work by Eppler (2006), there still tended to be articles and books that advocated the use of concept maps but excluded the use of linking words and cross-links (Carpetino-Moyet, 2007; D'Antoni, Pinto Zipp, & Olsen, 2009).

Established (2011-2015)

During the recent years of 2011-2015, the research and writing on concept maps in nursing education has continued. Studies have continued to look at concept maps as a learning strategy, but they have focused on specific strategies. For example, Spinola and Amendoeira (2014) found concept maps helpful in promoting self-reflection in nursing students. Noonan (2011) used concept maps to train perioperative nurses, and Taylor and Littleton-Kearney (2011) examined using concept maps with case study clinical rounds in a graduate physiology–pathophysiology course.

In addition, the study of concept maps and their influence on critical thinking with nursing students continues (Atay & Karabacak, 2012; Huang, Chen, Yeh, & Chung, 2012; Lee, Chiang, Liao, Lee, Chen, & Liang, 2013; Maneval, Filburn, Deringer, & Lum, 2011; Sinatra-Wilhelm, 2012). Yeo (2014) conducted a literature review on concept maps and critical thinking that identified eight factors affecting the successful implementation of concept mapping. Other studies looked at how concept maps affected examination scores. Brune (2013) found no significant increase in critical thinking scores or examination scores using concept maps as measured by the Health Science Reasoning Test. In contrast, Barrett (2014) found that concept maps improved critical thinking skills as measured by the California Critical thinking skills Test. Lin, Han, Pan, and Chen (2014) found enhanced critical thinking with concept maps, and several authors (Moattari, Soleimani, Moghaddam, & Mehbodi, 2014; Shellenbarger & Robb, 2015; Williams-Brennan & Flynn-Post, 2015) found concept maps to be a valuable strategy for improving critical thinking and promoting clinical reasoning. In addition, Jaafarpour, Aazami, and Mozafari (2015) found higher mean scores on cumulative tests with groups of nursing students that created concept maps. Burrell (2014) advocated best practices in teaching critical thinking, including concept mapping as a strategy.

A few new areas of research emerged during this time. One new research area is assessing the effects of combining concept maps with simulations in nursing education. One study found a significant correlation between nursing student self-confidence in simulation and concept maps (Samawi, Miller & Haras, 2014). Another new area of emerging research is assessing the use of concept maps within interdisciplinary education. For example, Bressington, Wells, and Graham (2011) used concept maps to explore how professional views and levels of knowledge influenced nurses' and social workers' perceptions of the approved mental health professionals' role. The other emerging trend during this period was more international writing and work on concept maps.

FUTURE RESEARCH IMPLICATIONS

As can be seen from the current literature review, a large body of work has informed the use of concept maps in nursing education. In addition, studies from other health professions, medical education, and patient education lend strength to the applicability of concept maps in teaching and learning. Even though a small number of studies demonstrated no statistically significant learning gains from the use of concept maps, the vast

majority of the evidence indicated that using concept maps in nursing education was effective in promoting critical thinking, clinical reasoning, integrating theory with clinical practice, and promoting self-reflection. So what does this mean for the next steps in studying concept maps in nursing education? Researchers and scholars need to move beyond the question "Are concept maps effective?" and investigate other emerging areas.

First, a major implication of this literature review is the need for nurse educators to be conceptually clear on what is labeled as a concept map. As was clear in this review, concept maps, mind maps, and clinical correlation maps have all been used in nursing education. However, a concept map as created by Novak and Gowin (1984) is a schematic device that links concepts through the theoretical premises of subsumption, progressive differentiation, and integrative reconciliation. These processes are evident when using linking words within the map structure. To foster in-depth and meaningful learning, nurse educators need to ensure that students incorporate these three processes in their map construction, along with the use of linking words. Concept maps were originally created based on a specific learning theory. For concept maps to be most effective, they need to be used in the manner for which they were designed.

Second, there is a need to understand and evaluate different scoring models for using concept maps in nursing education. The variation in the results of studies on concept maps and critical thinking in nursing education may be related to the variety of scoring formulas in use. West, Park, Pomeroy, and Sandoval (2002) investigated the use of two scoring models using a relational model and a structural model. A structural formula is based on the map's hierarchical structure, and a relational formula is based not on the structure but on the quality of the individual map components. Each of these types of scoring will lead to different results. Thus, this type of scoring, along with the qualitative assessment of maps as developed by Kinchin and Hay (2000, 2005, 2006), needs to be applied broadly to the study of concept maps in nursing education.

Third, more research is needed on the creation of serial concept maps (All & Huycke, 2007). It is important to understand how the sequential creation of connected and integrated maps affects thinking and learning, as well as clinical practice outcomes, for new graduates. This type of study is now possible with the advent of CmapTools, created by the Institute for Human and Machine Cognition (http://cmap.ihmc.us/products/). CmapTools is a free online software program that supports the creation of concept maps, as well as knowledge models. Knowledge models (Cañas et al., 2004) are multiple connected concept maps that can represent the knowledge a learner creates longitudinally. Knowledge models are essentially three-dimensional representations of the concepts and propositions a learner has identified (Cañas, Hill, & Lott, 2003). In nursing education, the study of knowledge models could facilitate the understanding of how students transition to practicing professional and, ultimately, to clinical expert. In addition, it would be important to know whether the development of knowledge models facilitates the development of expertise.

Fourth, the use of concept maps and simulation is an area in need of additional research. Many nursing programs across the country are integrating high-fidelity simulation experiences into the clinical requirements for nursing students, but little research investigates how student prepare for simulation or how they incorporate simulated experiences into client care. There is a need to understand whether and how concept maps can support student learning in simulated environments. For example, concept maps have been shown to foster the development of critical thinking (Daley, Shaw, Balistrieri, Glasemapp, & Piacentine, 1999). Could critical thinking development be further enhanced by combining concept maps and simulation? Also, there is a need to understand whether and how concept maps can be used to assist students in preparing for simulation experiences.

Finally, there is a need to understand the impact of a concept map–centered learning environment on nursing education. Novak and Cañas (2008) called for a new model of education based on this idea. A concept map–centered learning environment means that knowledge models and "concept maps can thus become an artifact around which the various activities of the learning process can be centered" (Novak & Cañas, 2008, p. 17). This type of learning environment has major implication for nursing education. The influence of this type of educational model could be significant and link well with current concept-based nursing education curricula (Giddens & Brady, 2007).

CONCLUSION

Over the past 25 years, nursing education scholars and researchers have investigated the use of concept maps in teaching and learning. This research has progressed through various stages and greatly expanded the understanding and use of concept maps in nursing. It is now time to move this research into areas that can further transform our educational practices.

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